

can be implemented by computer program instructions and/or means. These computer program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions specified in the flowcharts or block diagrams.

The exemplary and alternative embodiments described above may be combined in a variety of ways with each other. Furthermore, the steps and number of the various steps illustrated in the figures may be adjusted from that shown.

It should be noted that the present invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, the embodiments set forth herein are provided so that the disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. The accompanying drawings illustrate exemplary embodiments of the invention.

Although the present invention has been described in terms of particular exemplary and alternative embodiments, it is not limited to those embodiments. Alternative embodiments, examples, and modifications which would still be encompassed by the invention may be made by those skilled in the art, particularly in light of the foregoing teachings.

As used above “substantially,” “generally,” and other words of degree are relative modifiers intended to indicate permissible variation from the characteristic so modified. It is not intended to be limited to the absolute value or characteristic which it modifies but rather possessing more of the physical or functional characteristic than its opposite, and preferably, approaching or approximating such a physical or functional characteristic.

Those skilled in the art will appreciate that various adaptations and modifications of the exemplary and alternative embodiments described above can be configured without departing from the scope and spirit of the invention. Therefore, it is to be understood that, within the scope of the appended claims, the invention may be practiced other than as specifically described herein.

VI. INDUSTRIAL APPLICABILITY

The invention has industrial applicability to assist in the resuscitation of injured individuals who have received burns. The invention brings expertise out of the expert burn centers to medical staffs that may have no expertise and thus the care level provided by those medical staffs to patients should improve. The semi-closed loop system and the closed loop system are both useable in caring for burn patients when the medical staff does not have a sufficient level of experience and/or background to care for the burn patient, particularly during transport to a burn center.

VII. GLOSSARY

- ABA—American Burn Association
- ABLS—Advanced Burn Life Support
- HPB—Hours Post Burn
- LR—lactated Ringer’s solution
- PID—proportional-integral-derivative
- TBSA—Total Body Surface Area
- % TBSA—percentage Total body surface area
- UO—Urinary Output
- USAISR—U.S. Army Institute of Surgical Research
- UTMB—University of Texas Medical Branch

We claim:

1. A system for use in resuscitating a patient comprising: a urine sensor; an infusion pump; and a processor connected to said urine sensor and said infusion pump, said processor having means for calculating an infusion rate using an infusion rate model based on at least a current infusion rate, a current urinary output, and infusion rate model based constants, the new infusion rate is calculated using the following equation

$$I_t = I_{t-1} + e(t) \times \frac{IRC_t}{UOC_t}$$

where  $I_t$  is the new infusion rate,  $I_{t-1}$  is the last infusion rate,  $e(t)$  is the urinary output error between the current urinary output and a target urinary output,  $IRC_t$  is the infusion rate constant at time t based on the hours post burn, and  $UOC_t$  is the urinary constant, and

means for controlling operation of said infusion pump based on the calculated infusion rate.

2. The system according to claim 1, wherein the infusion rate constant decreases based on hours post-burn in at least two steps.

3. The system according to claim 1, wherein the urinary output error is further multiplied by at least one of a modifier based on a patient’s weight, a modifier based on a percentage of a total body surface area burned, and a Gaussian function calculated using an end point of a target urinary output range furthest from the current urinary output.

4. The system according to claim 1, wherein the urinary output error is further multiplied by a Gaussian function calculated using an end point of a target urinary output range furthest from the current urinary output, where the Gaussian function is calculated using

$$G = 1 - Ae^{-(X-B)^2/C^2}$$

where A is set to 1; X is set to the current urinary output; B is set to the furthest end point of the target urinary output range; and C is set to 5.

5. The system according to claim 1, further comprising a timer connected to said processor, said calculating means calculates a new infusion rate when said timer expires after running for a predetermined time.

6. The system according to claim 5, wherein the predetermined time is based on hours post burn.

7. The system according to claim 1, further comprising a display, and

said processor further includes means for driving said display and receiving information from said display of information entered by a user including an infusion rate different than the infusion rate calculated, and

8. The system according to claim 1, further comprising a selector with at least two positions including a closed loop position and a semi-closed loop position, said selector is in communication with said processor.

9. The system according to claim 1, further comprising means for notifying medical staff when a problem has arisen with the patient.

10. The system according to claim 1, further comprising means for notifying medical staff when a problem has arisen with the system.